Camera Tips & Tricks

Choosing the Right Cameras

License plate recognition differs from other kinds of video surveillance.

Normally, you choose cameras based on their ability to provide the best possible images for viewing by the human eye.

However, when choosing cameras for use with license plate recognition, only the small part of the images which contains the actual license plates is important. Therefore, keep some basic features in mind when choosing cameras for use with license plate recognition:

- **Resolution:** Choose cameras which have a sufficient resolution.
- **Dynamic range:** Choose cameras which have a sufficient dynamic range. A camera's dynamic range determines, among other things, its sensitivity in low- and high-light conditions, how it reacts to changing light conditions, and how sensitive it is to infrared lighting.
- **Shutter speed:** Choose cameras which give you the ability to set a shutter speed fit for your requirements. See also Lens & Shutter Speed on page 30.
- **Undesired features:** Choose cameras which give you the ability to disable image enhancement techniques, such as auto-gain and contrast/contour enhancement. For license plate recognition, you generally want your images as raw as possible. See also Undesired Camera Features on page 34.
- **No MPEG:** License plate recognition will not work if cameras use MPEG compression; choose cameras which have alternative image compression methods, such as JPEG.
- **Lenses:** Choose cameras which have—or lets you choose—lenses which are suitable for your required camera resolution and your external lighting conditions. For example, when infrared lighting is used it is preferable to also use a lens with an infrared pass filter or at least a lens which is compensated for infrared light. Otherwise you get a focus shift when the environment gets dark. To achieve a better dynamic range for your camera it is sometimes recommended to use a lens with auto-iris.
    - *Iris* is the adjustable opening (a.k.a. aperture) used for controlling the amount of light coming through a lens. Iris thus has a significant effect on the exposure of images.

Contrast

When determining the right contrast for license plate recognition, consider the difference in gray value (when images are converted to 8-bit grayscale) between the license plate's characters and the license plate's background color:

Good contrast

Acceptable contrast; recognition is still possible

Too little contrast; recognition is not possible

Pixels in an 8-bit grayscale image can have color values ranging from 0 to 255, where grayscale value 0 is absolute black and 255 is absolute white. When you convert your input image to an 8-bit grayscale image, the minimum pixel color value difference between a pixel in the foreground and a pixel in the background should be at least 15.

Note that noise in the image, the use of compression, or similar can make it difficult to determine what the colors of a license plate's characters and background are (see also Physical Environment on page 31 and Undesired Camera Features on page 34).

Lens & Shutter Speed

When configuring cameras' lenses and shutter speeds for license plate recognition, bear in mind the following:

- **Focus:** Always make sure the license plate is in focus when images are to be used for license plate recognition.

- **Auto-iris:** If using an auto-iris lens, always set the focus with the aperture as open as possible. In order to make the aperture open, you can use ND filters or—when the camera supports manual configuration of the shutter time—the shutter time can be set to very short.

    - *ND Filters* (a.k.a. *Neutral Density filters* or *gray filters*) basically reduce the amount of light coming into a camera; effectively working as "sunglasses" for the camera. ND filters thus affect the exposure of images (see also Physical Environment on page 31).

- **Infrared:** If using an infrared light source, note focus may change when switching between visible light and infrared light. You can avoid the change in focus by using an infrared compensated lens, or by using an infrared pass filter. Note that when using an infrared pass filter, an infrared light source is required—also during daytime.

- **Vehicle speed:** When vehicles are moving while recorded for license plate recognition, cameras' shutter time should be short enough to avoid motion blur. A rule of thumb for determining the longest suitable shutter time is:

    - **Vehicle speed in km/h:** Shutter time in seconds = 1 second / (11 × max vehicle speed in kilometers per hour)

    - **Vehicle speed in mph:** Shutter time in seconds = 1 second / (18 × max vehicle speed in miles per hour)

    where / denotes "divided by" and × denotes "multiplied by."

    The following table provides guidelines for recommended camera shutter speeds at different vehicle speeds:

Shutter time in seconds	Max. vehicle speed in kilometers per hour	Max. vehicle speed in miles per hour
1/50	4	2
1/100	9	5
1/200	18	11
1/250	22	13
1/500	45	27
1/750	68	41
1/1000	90	55
1/1500	136	83
1/2000	181	111
1/3000	272	166
1/4000	363	222

Physical Environment

When mounting and using cameras for license plate recognition, bear in mind the following environmental factors:

- **Much light:** Too much light in the environment can lead to overexposure or smear.
    - *Overexposure* is when images are exposed to too much light, resulting a in a burnt-out and overly white appearance. To avoid overexposure it is recommended that you use a camera with a high dynamic range and/or use an auto-iris lens. *Iris* is the adjustable opening (a.k.a. aperture) used for controlling the amount of light coming through a lens. Iris thus has a significant effect on the exposure of images.
    - *Smear* is an effect leading to unwanted light vertical lines in images; it is frequently linked to slight imperfections in cameras' CCD imagers (the sensors used to digitally create the images). In general, CCD imagers with large surfaces are less sensitive to smear than CCD imagers with small surfaces. Cameras with CMOS imagers (a different type of sensors, with a higher noise immunity) are less sensitive to smear than cameras with CCD imagers.

License plate image with smear

- **Little light:** Too little environmental or external lighting can lead to underexposure.
    - *Underexposure* is when images are exposed to too little light, resulting in a dark image with hardly any contrast. When auto-gain cannot be disabled (for more information about gain, see Undesired Camera Features on page 34) or when you are not able to configure a maximum allowed shutter time for capturing moving vehicles (see Lens & Shutter Speed on page 30), too little light will initially lead to

gain noise and motion blur in the images, and ultimately to underexposure. Underexposure can be avoided by using sufficient external lighting and/or by using a camera which has sufficient sensitivity in low-light environments without using gain. In general, cameras which have CCD imagers with large surfaces are more light-sensitive than cameras which have CCD imagers with small surfaces.

- **Infrared:** Another popular way of overcoming difficult environmental lighting conditions is to use artificial infrared lighting combined with an infrared-sensitive camera with an infrared pass filter. Retroreflective license plates are particularly suitable for use with infrared lighting.

  - *Retroreflectivity* is achieved by covering surfaces with a special reflective material which sends a large portion of the light from a light source straight back along the path it came from. Retroreflective objects appear to shine much more brightly than other objects; at night they can thus be seen clearly from considerable distances. Retroreflectivity is frequently used for road signs, and is also used for different types of license plates.

- **Weather, etc.:** Snow, very bright sunlight, etc. may require special configuration of cameras.

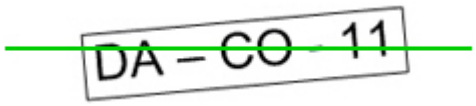
- **Plate condition:** Vehicles may have damaged license plates. License plates may occasionally have been damaged deliberately in attempts to avoid detection. Vehicles may also simply have dirty license plates.

- **Camera condition:** Camera lenses may accumulate dirt over time.

Physical Positioning of Cameras

When mounting cameras for license plate recognition, bear in mind the following:

- **Single-line rule:** Mount the camera in such a way that you are able to take an image of a single line license plate recorded by the camera, and draw a horizontal line that crosses both the left and right edge of the license plate:

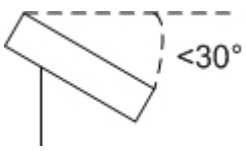


Acceptable mounting

Incorrect mounting

- **Plate in image center:** Mount the camera in such way that an ideal image of the license plate is captured when the license plate is in the center of the recorded image.

- **Vertical angle:** The maximum vertical view angle of a camera used for license plate recognition is 30 degrees:



- **Horizontal angle:** The maximum horizontal view angle of a camera used for license plate recognition is 25 degrees. In most systems the horizontal angle is somewhere between 15 and 20 degrees.

- **Blocking objects:** Avoid possible blocking objects in the view path of the camera, such as pillars, barriers, fences, gates, etc. Remember that barriers, gates, etc. are likely to be moveable between different positions.

Resolution

The term *pixels per stroke* is used to define a minimum requirement for license place recognition. The following illustration outlines what is meant by *stroke*:

Because the thickness of strokes depends on country and plate style, measurements like pixels/cm or pixels/inch are not used.

The resolution for best license plate recognition performance should be at least 2.7 pixels/stroke.

- For single line US plates (plate width 30.5 cm; stroke width around 0.7 cm) this typically means that the plate width in the image must be at least 130 pixels.

- For single line European style plates (plate width 52 cm; stroke width around 1 cm) this typically means that the plate width in the image must be at least 170 pixels.

When vehicles are moving when recorded, and an interlaced camera is used, only a half of image can be used (only the even lines). This means that the resolution requirements almost must be doubled.

- For single line US plates (plate width 30.5 cm; stroke width around 0.7 cm) this typically means that the plate width in the image must be at least 215 pixels.

- For single line European style plates (plate width 52 cm; stroke width around 1 cm) this typically means that the plate width in the image must be at least 280 pixels.

What is interlacing? Interlacing is a method determining how an image is refreshed when shown on a screen. With interlacing, the image is refreshed by first scanning every other line in the image, then scanning every opposite line, and so forth. This allows for a faster refresh rate because less information must be processed during each scan. However, in some situations, interlacing may cause flickering, or the changes in only half of the image's lines for each scan may be noticeable.

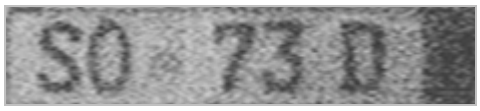
Interlaced image of a moving car

Undesired Camera Features

When configuring cameras for license plate recognition, bear in mind the following:

- **Automatic gain adjustment:** One of the most common types of image interference caused by cameras is gain noise.
    - *Gain* is basically the way in which a camera takes a picture of a scene and distributes light into it. If light is not distributed optimally in the image, the result is gain noise.

Controlling gain requires that complex algorithms are applied, and many cameras have features for automatically adjusting gain. Unfortunately, such features are not always helpful for cameras used for license plate recognition. It is therefore recommended that you configure your cameras' auto-gain functionality to be as low as possible. Alternatively, disable the cameras's auto-gain functionality altogether.



License plate image with gain noise

Tip: In dark environments, gain noise can also be avoided when your external lighting is sufficient.

- **Automatic enhancement:** Some cameras use contour, edge or contrast enhancement algorithms to make images look better to the human eye. However, such algorithms can interfere with the algorithms used in the license plate recognition process. It is therefore recommended that you disable cameras' contour, edge and contrast enhancement algorithms whenever possible.

- **Automatic compression:** License plate recognition will not work if cameras use MPEG compression. Even if cameras compress recorded images with other compression algorithms, such as JPEG, high compression rates can have a negative influence on the quality of license plate images. When a high compression rate is used, more license plate resolution is required in order to achieve optimal license plate recognition performance. If JPEG compression is used, it will have almost no negative influence on license plate recognition performance, as long as the images are saved with a JPEG quality level of 80% or above, and images have normal resolution, contrast and focus as well as a low noise level.

Left: License plate image saved with a JPEG quality level of 80% (i.e. low compression); acceptable
Right: License plate image saved with a JPEG quality level of 50% (i.e. high compression); unacceptable